CLAIMS

What is claimed is:

1. A method of increasing the luminescent bandwidth of a photoelectric semiconductor device by separate confinement heterostructure , the method comprising:

> controlling the widths of different separate confinement heterostructures and producing multi-layer quantum well structures having different widths or constituent materials with the carrier distribution therein is controlled by either electrons or holes; and
>
> shortening the width of the separate confinement heterostructures in compliance with the mobility of holes, and thereby the time for the electrons to be captured into the multi-layer quantum well structures is approximate to the time for the holes to be captured into the multi-layer quantum well structures.

2. The method according to claim 1 wherein the relationship between time for holes to enter the multi-layer quantum well structures and the time for electrons to be captured by the quantum well structures is satisfactory for the criterion of: | the time for holes to enter the quantum well structures ($\tau_{p,diffusion)}$ - the time for electrons to be captured by the quantum well structure ($\tau_{n,cap)}$ | < 1 picosecond.

3. The method according to claim 1 wherein the the width of the separate confinement heterostructures is shortened to allow the time for holes to enter the multi-layer quantum well structures to be limited within 5 picoseconds.

4. The method according to claim 1 wherein the energy levels of the multi-layer quantum well structures is sufficient to provide desirable luminescent

wavelengths by stacking multi-layer quantum well structures having different widths or constituent materials.

5. The method according to claim 1 wherein the step of shortening the width of the separate confinement heterostructures in compliance with the mobility of holes is accomplished by shortening the separate confinement heterostructures located in the proximity of a P-type semiconductor side to allow the time for holes to reach the multi-layer quantum well structures to be limited within 5 picoseconds.

6. The method according to claim 1 wherein at the step of shortening the width of the separate confinement heterostructures in compliance with the mobility of holes, the width of the separate confinement heterostructures in the proximity of a N-type semiconductor side is larger than the separate confinement heterostructures located in the proximity of the P-type semiconductor side, so as to allow the difference between time for holes to reach the multi-layer quantum well structures and the time for electrons to reach the multi-layer quantum well structures to be limited within 3 picoseconds.

7. The method according to claim 1 wherein the separate confinement heterostructures located in the proximity of P-type semiconductor side includes an extremely thin N-type semiconductor, and wherein a width of the extremely thin N-type semiconductor is not greater than 5 nm and is used to prevent the dopant of the P-type semiconductor from penetrating into the quantum well structures.

8. The method according to claim 1 wherein the following arithmetic model is used to determine which carrier is the dominant carrier:

$$\tau_{LF} = \tau_{p,diffusion} + \tau_{n,diffusion} + \tau_{cap,p} + \tau_{cap,n} = \frac{d_p^2}{4D_p} + \frac{d_n^2}{4D_n} + \frac{d_p \tau_{cp}}{W} + \frac{d_n \tau_{cn}}{W}$$

where d_p and d_n respectively represents the distance that the hole or electron diffused to the quantum well, D_p and D_n represent the diffusion coefficients of semiconductor material, W represents the width of the multi-layer quantum well structures, $d_p \tau_{cp}$ and $d_n \tau_{cn}$ respectively represent the electron capture time and hole

capture time according to the calculation result derived based on quantum physics, and $\tau_{p,diffusion}$, $\tau_{cap,p}$, $\tau_{n,diffusion}$, and $_{cap,n}$ respectively represent the diffusion time of the holes in the separate confinement heterostructure, the diffusion time of the electrons in the separate confinement heterostructure, the equivalent hole capture time of the multi-layer quantum well structures, and the equivalent electron capture time of the multi-layer quantum well structures, and wherein an equivalent carrier capture time of the multi-layer quantum well structures is equal to the product of the carrier capture time of the multi-layer quantum well structures multiplied by a volume ratio of d_p/W or d_n/W.

9. The method according to claim 8 wherein the time associated with holes $\tau_{p,total}$ is defined as the sum of the diffusion time of the holes in the separate confinement heterostructure plus the equivalent hole capture time of the multi-layer quantum well structures, and is compared with the time associated with electrons $\tau_{n,total}$ being defined as the sum of the diffusion time of the electrons in the separate confinement heterostructure plus the equivalent electron capture time of the multi-layer quantum well structures.

10. The method according to claim 9 wherein if $\tau_{p,total} > \tau_{n,total}$, electrons are sufficient to enter the two-dimensional energy level of the multi-layer quantum well structures earlier and thereby result in a higher electron density in the proximity of the N-type semiconductor side, and the holes that enters the two-dimensional energy level of the multi-layer quantum well structures later is similarly distributed according to the distribution of the electrons, so that the two-dimensional carrier distribution in the proximity of the N-type semiconductor side within the multi-layer quantum well structures is relatively high.

11. The method according to claim 9 wherein if $\tau_{n,total} > \tau_{p,total}$, holes are sufficient to enter the two-dimensional energy level of the multi-layer quantum well structures earlier and thereby result in a higher hole density in the proximity of the P-type semiconductor side, and the electrons that enters the two-dimensional energy level of the multi-layer quantum well structures later is similarly distributed according to the distribution of the holes, so that the two-dimensional carrier distribution in the proximity of the P-type semiconductor side within the multi-layer quantum well structures is relatively high.

12. The method according to claim 9 wherein if $\tau_{p,total} > \tau_{n,total}$, holes are selected as the dominant carrier within the multi-layer quantum well structures, so as to obtain a temperature sensitivity and a better temperature coefficient due to the relatively large equivalent mass of holes.

13. The method according to claim 9 wherein if $\tau_{n,total} > \tau_{p,total}$, electrons are selected as the dominant carrier within the multi-layer quantum well structures, so as to obtain a relatively uniform carrier distribution within the multi-layer quantum well structures and a relatively larger gain bandwidth.

14. The method according to claim 1 wherein the photoelectric semiconductor device is one of a semiconductor optical amplifier, a superluminescent diode, and a semiconductor laser, and is adapted for III-V semiconductors used in an optical communication system.

15. The method according to claim 1 wherein the separate confinement heterostructure is formed from one group of II-VI semiconductors, III-V semiconductors, and IV semiconductors, combinations of II-VI semiconductors, III-V semiconductors, and IV semiconductors, and optionally includes a plurality of chemical elements.

16. The method according to claim 1 wherein the multi-layer quantum well structures are formed from one group of II-VI semiconductors, III-V semiconductors, and IV semiconductors, and optionally includes a plurality of chemical elements.